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(54) **SURGICAL STAPLING DEVICE WITH PARALLEL JAW CLOSURE**

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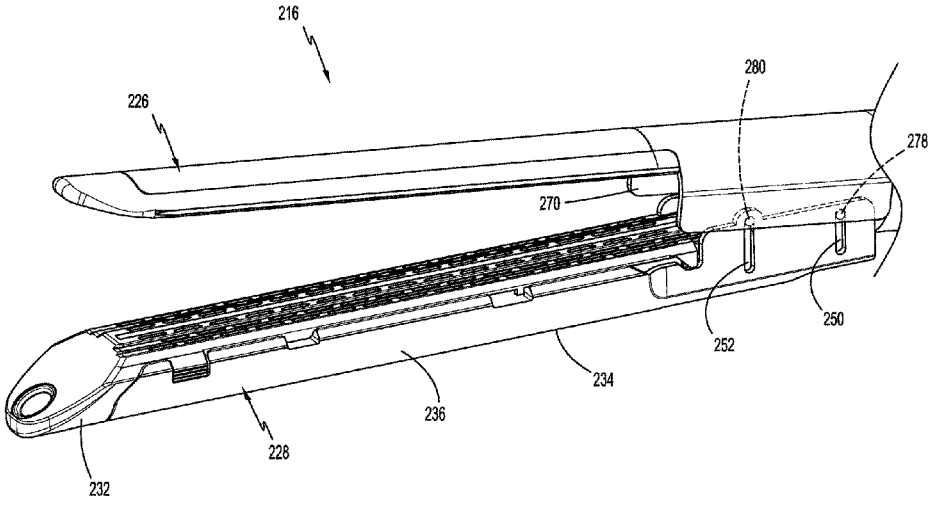
(57) **ABSTRACT**

A surgical stapling device includes a tool assembly having an anvil, a cartridge assembly movable in relation to the anvil between open and clamped positions, a drive member, and a biasing mechanism or member. The biasing mechanism or member is configured to urge the cartridge assembly in relation to the anvil assembly to its fully open position to provide access to tissue during a surgical procedure.

20 Claims, 16 Drawing Sheets



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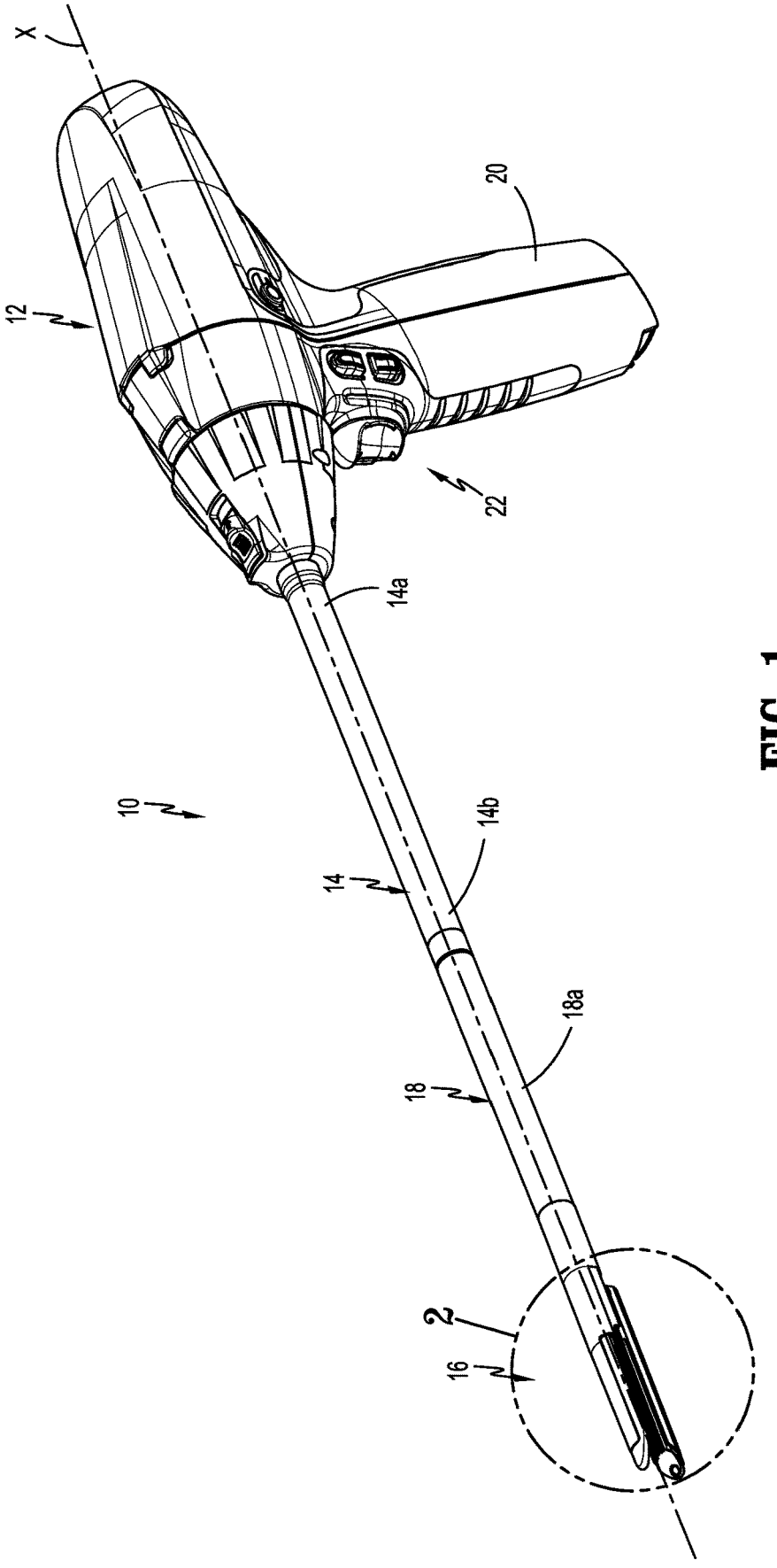

FIG. 1

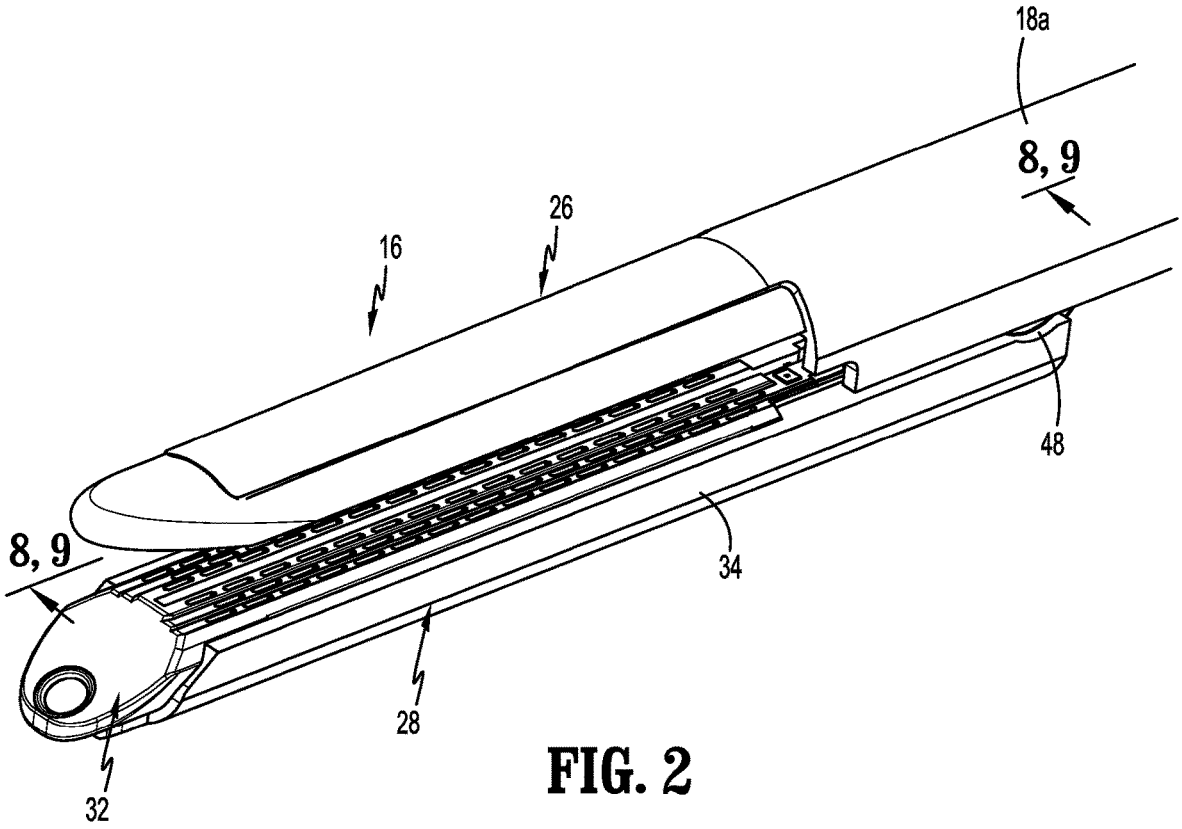

FIG. 2

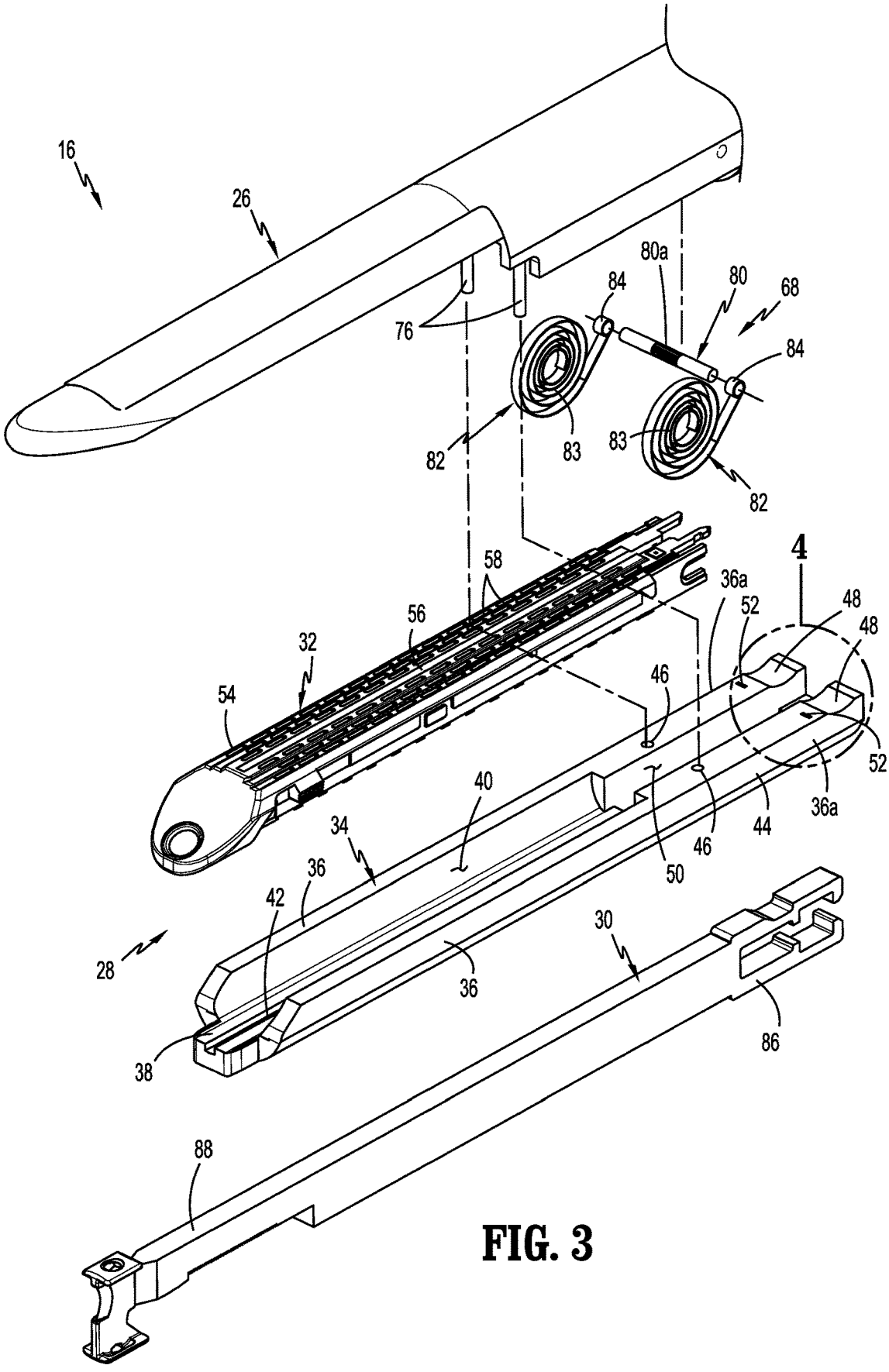
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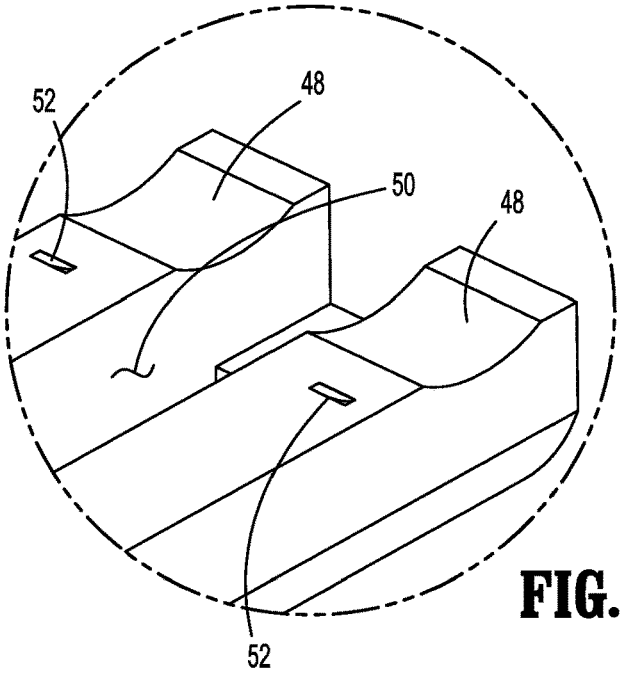
FIG. 3



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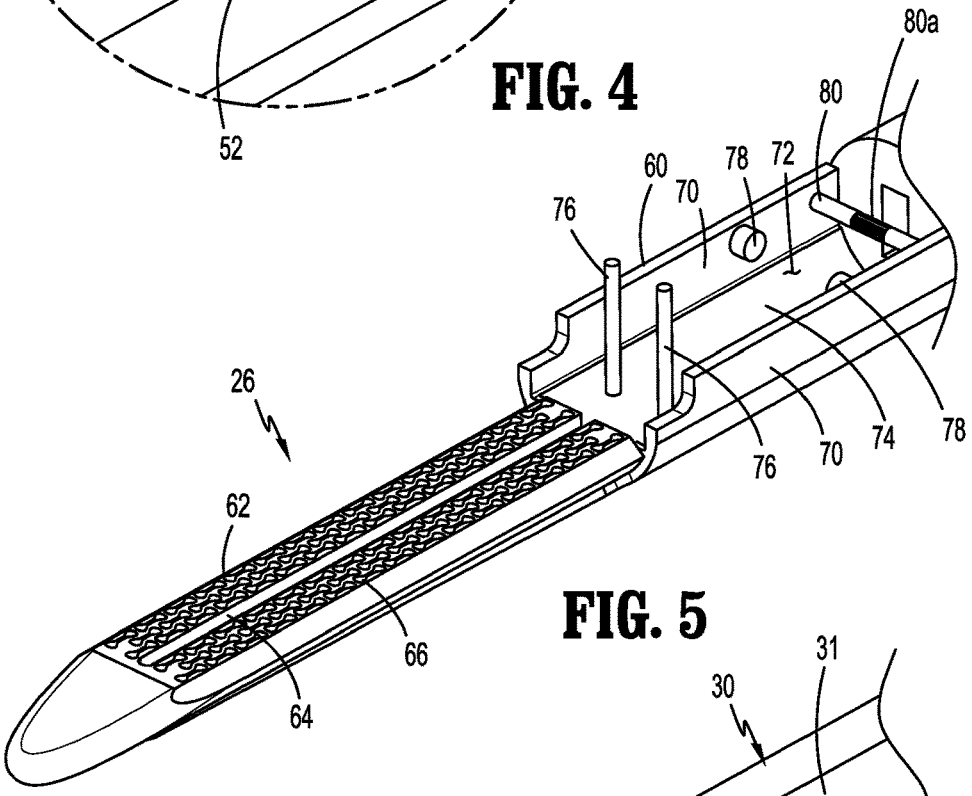
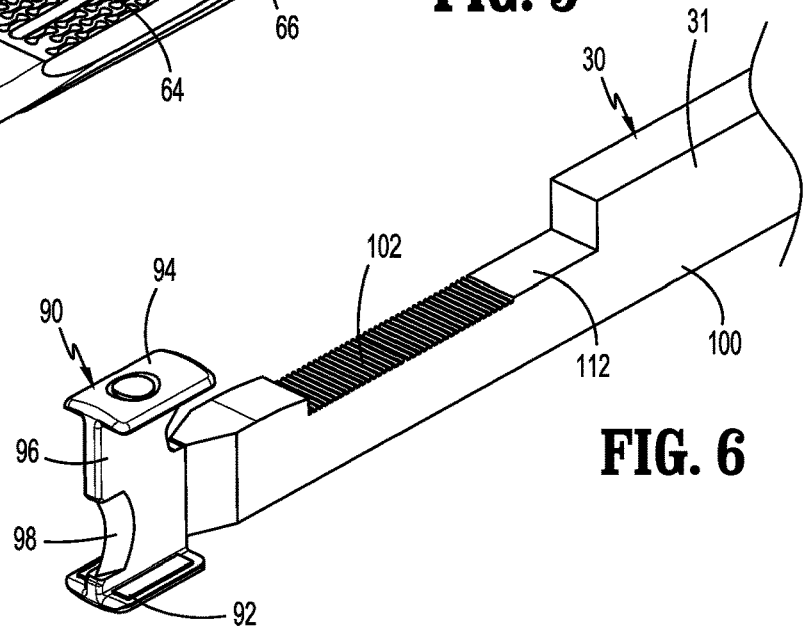


FIG. 5



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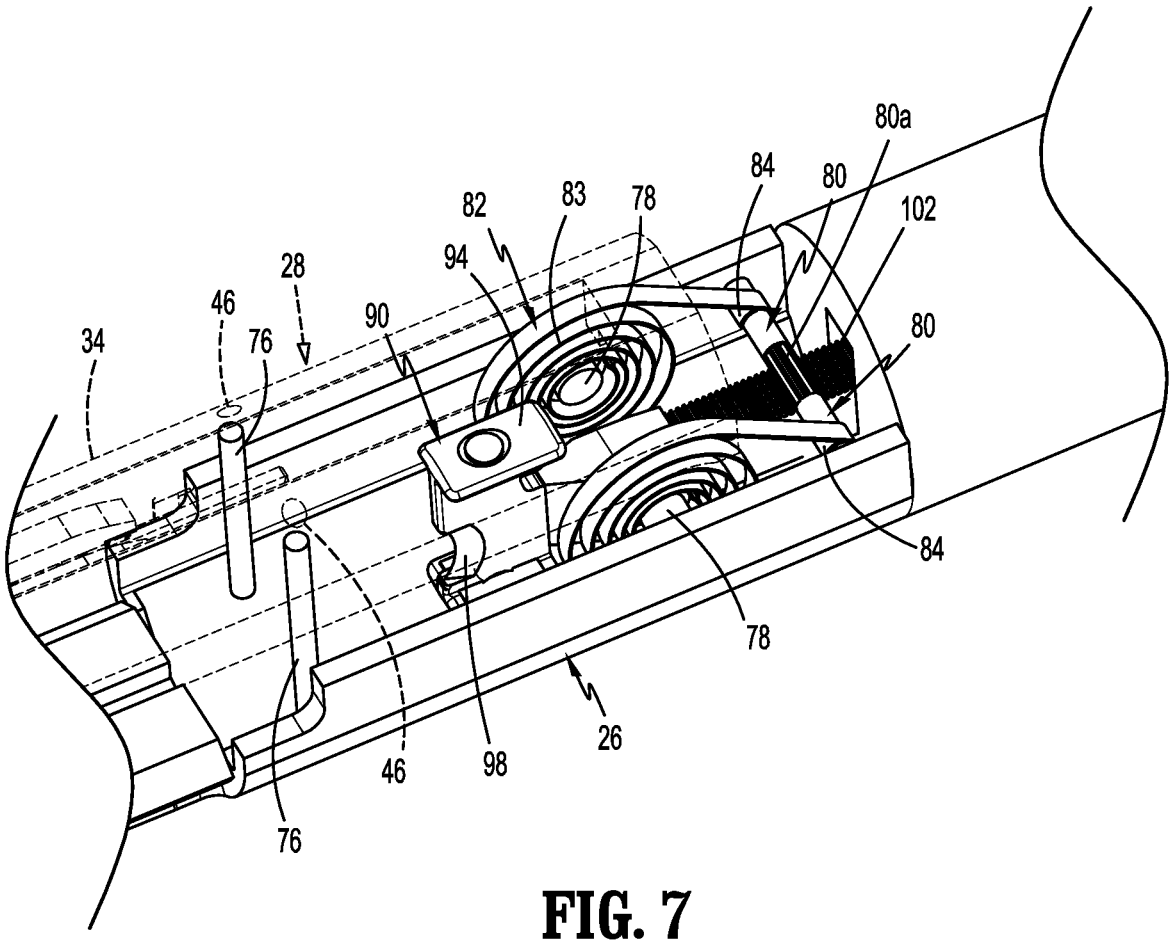

FIG. 7

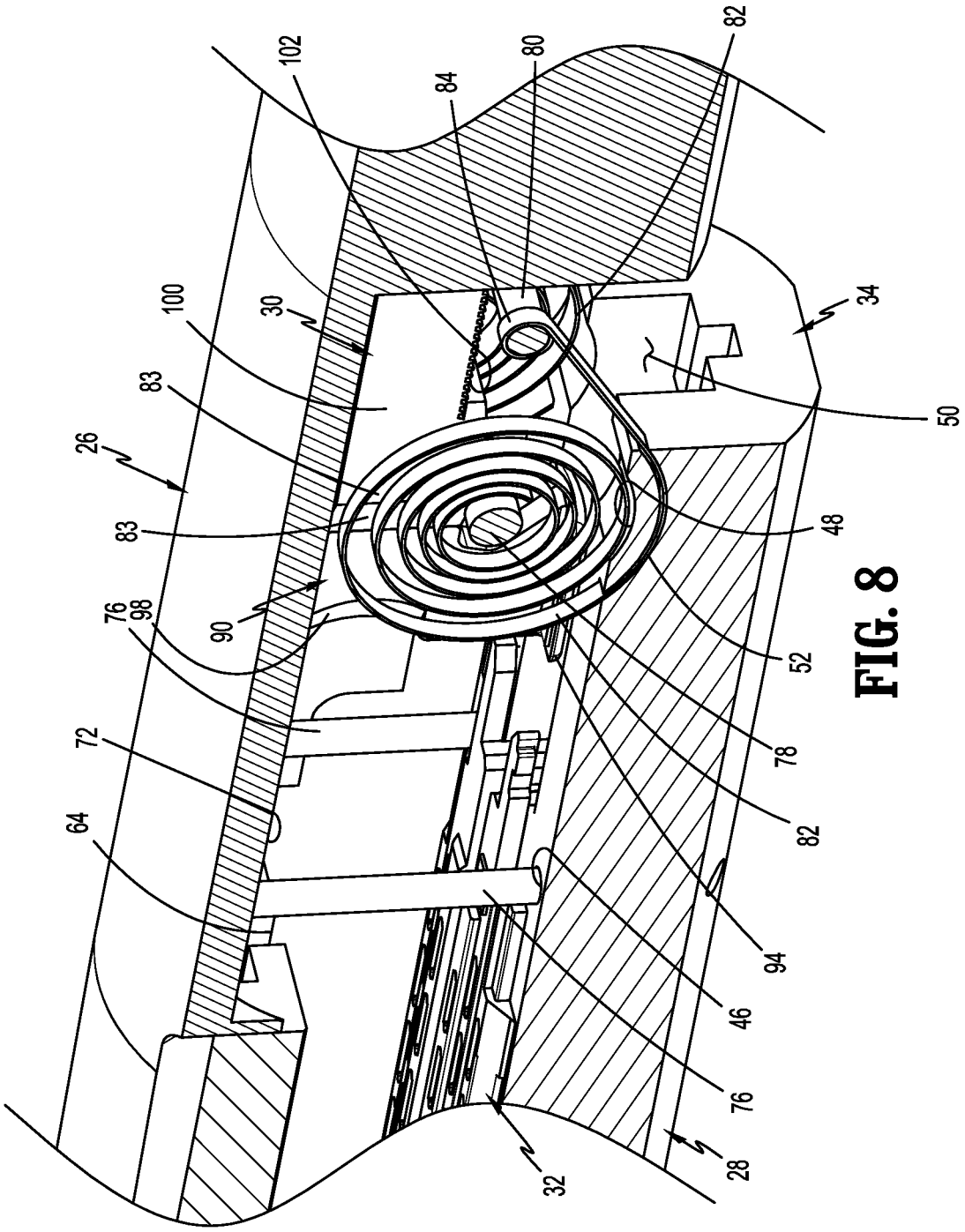
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FIG. 8

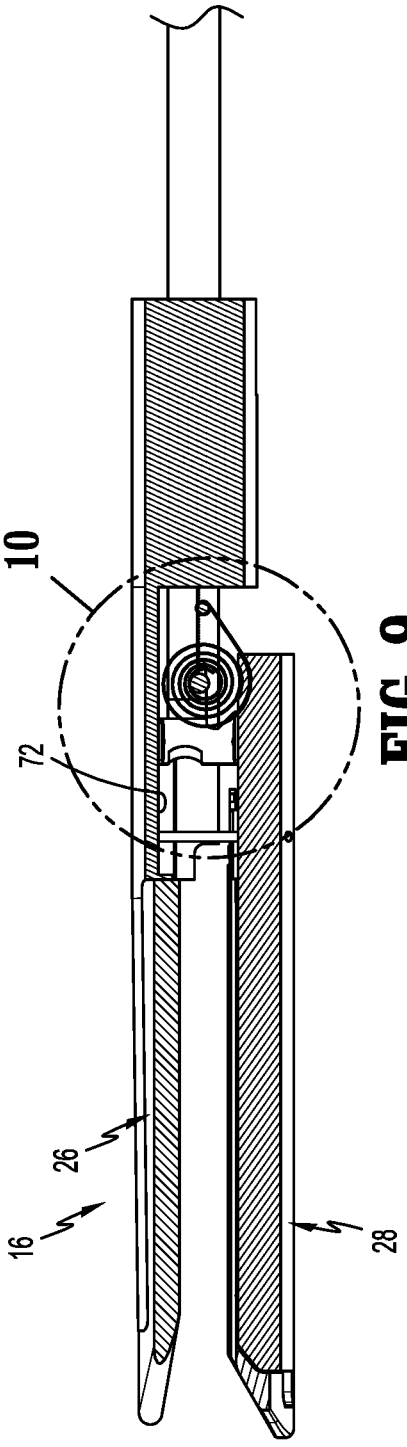
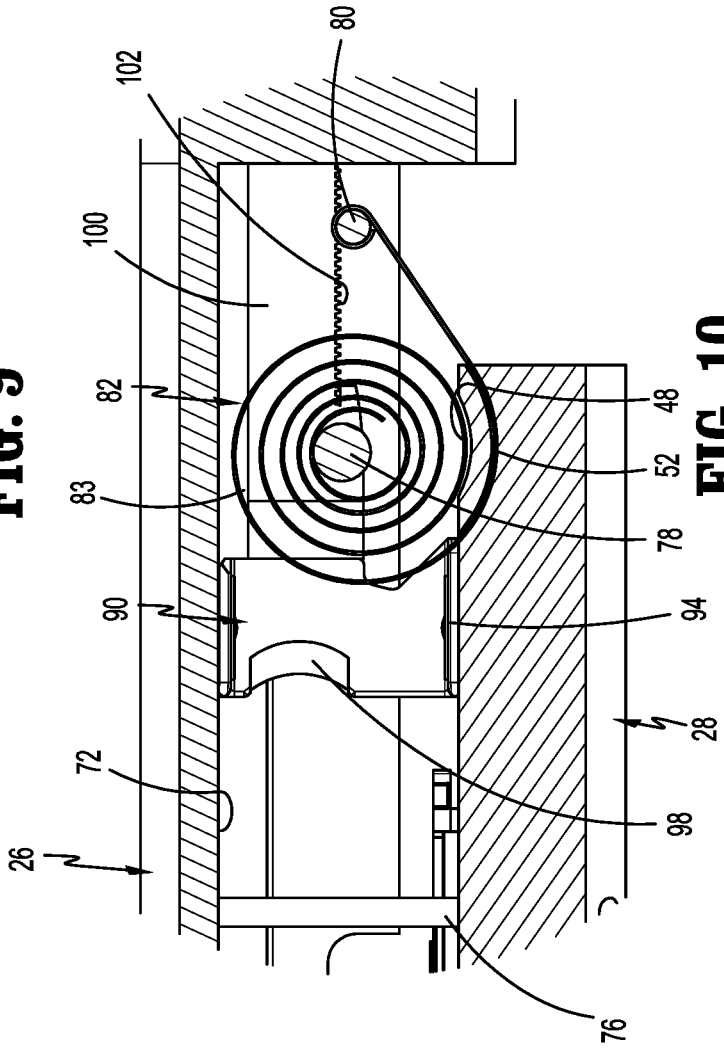


FIG. 9



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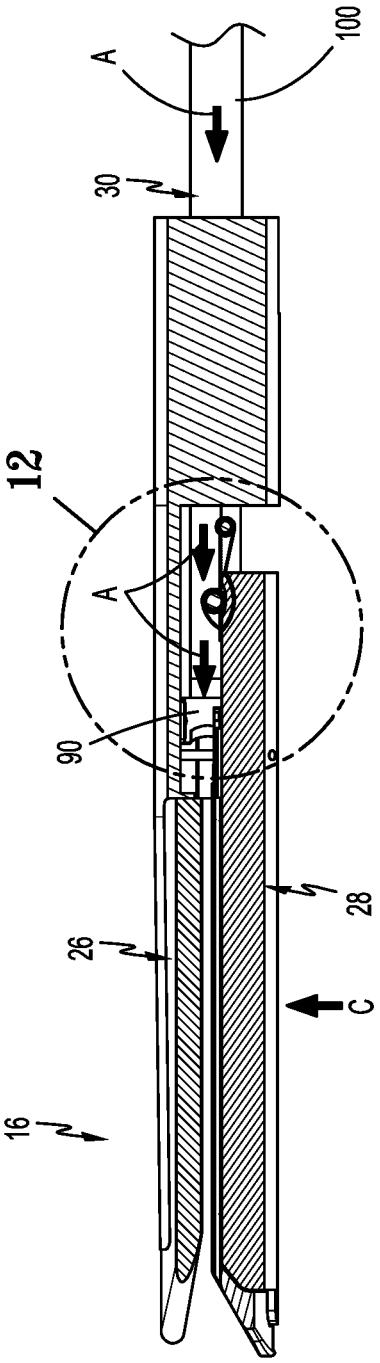
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FIG. 11

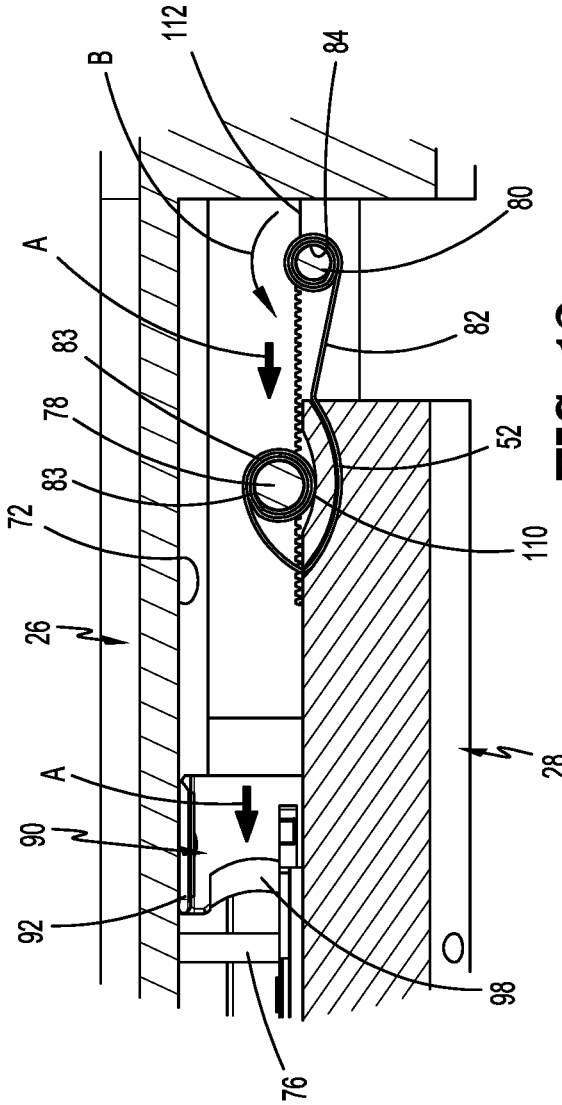
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FIG. 12

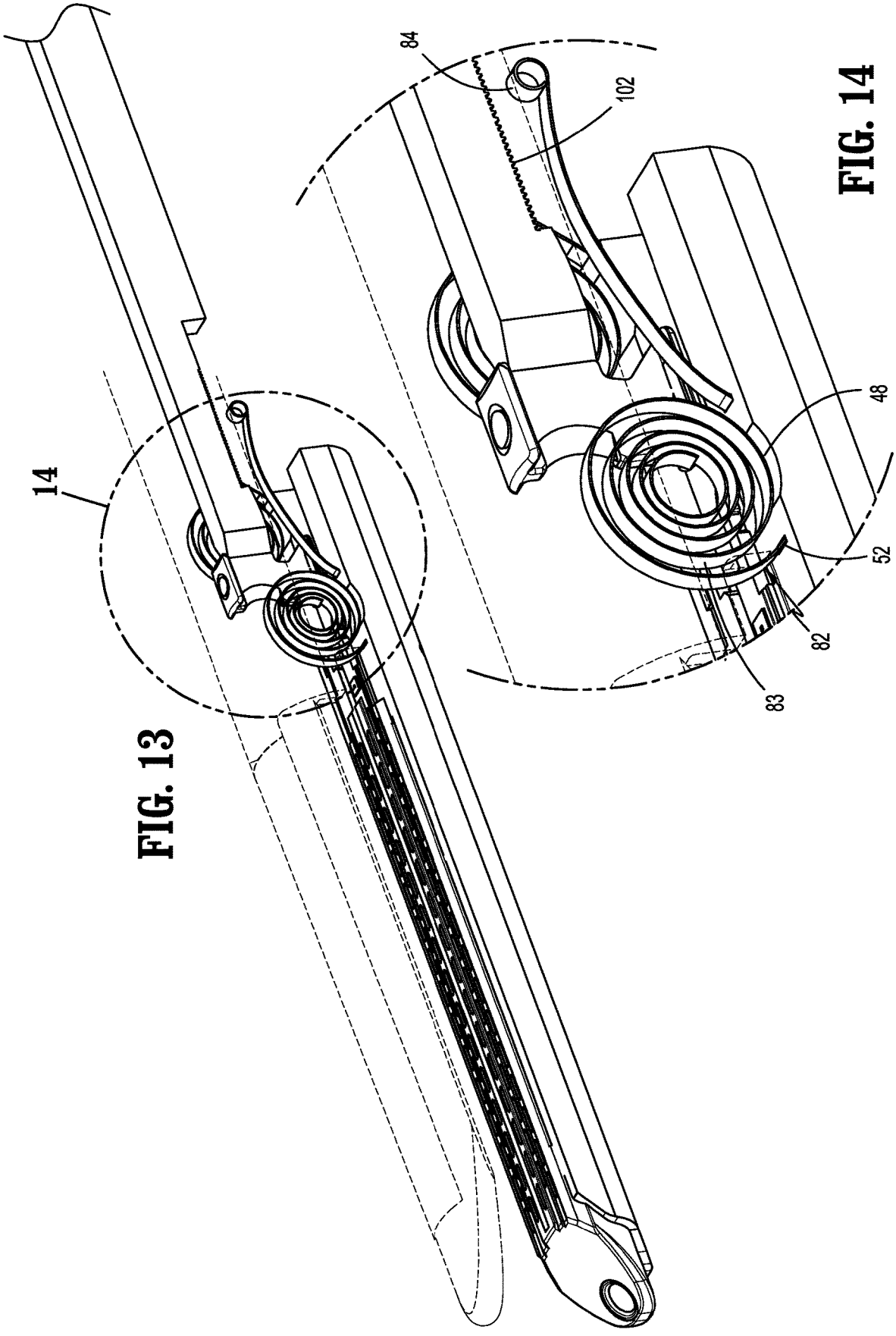


FIG. 13

FIG. 14

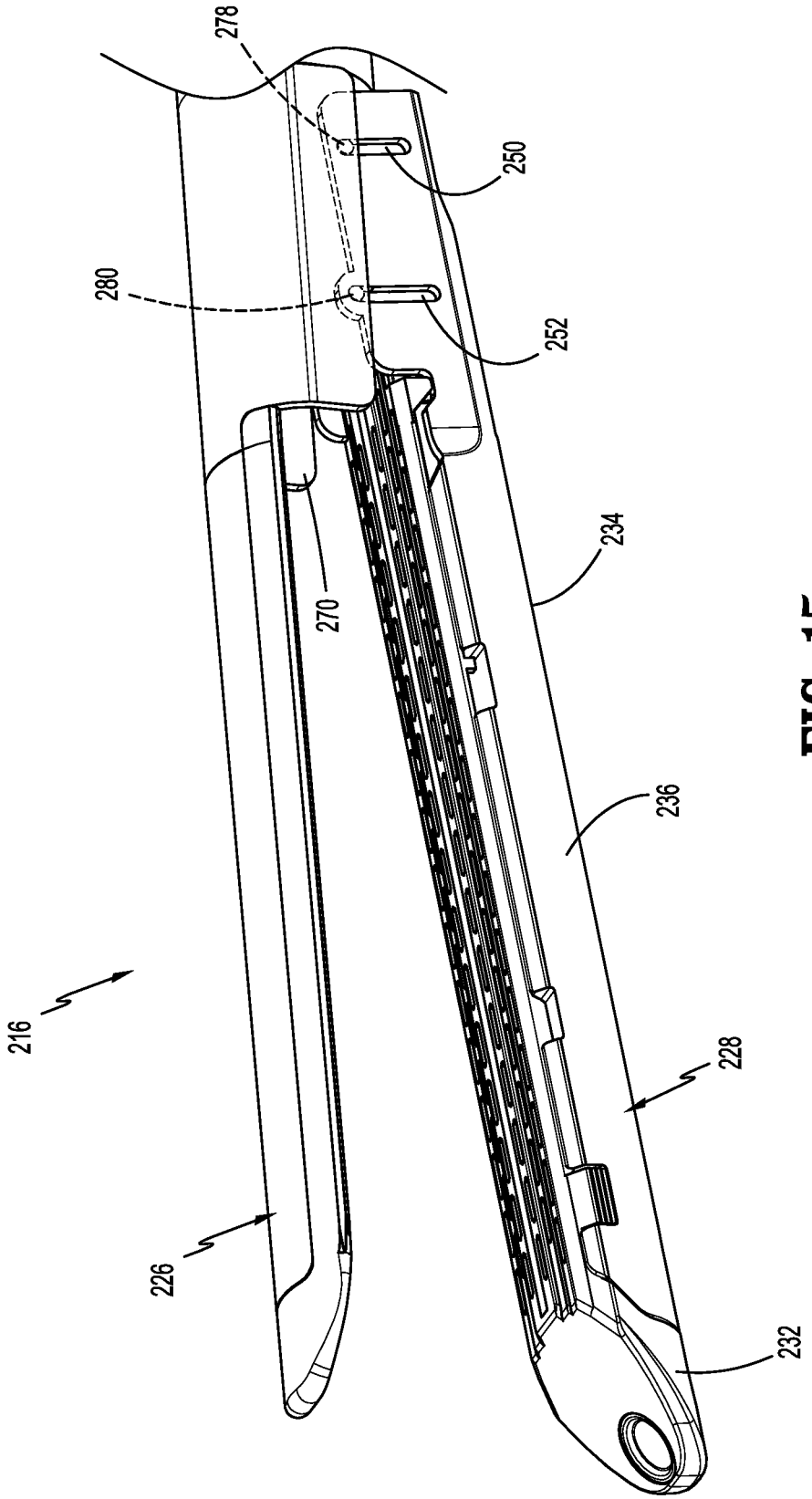
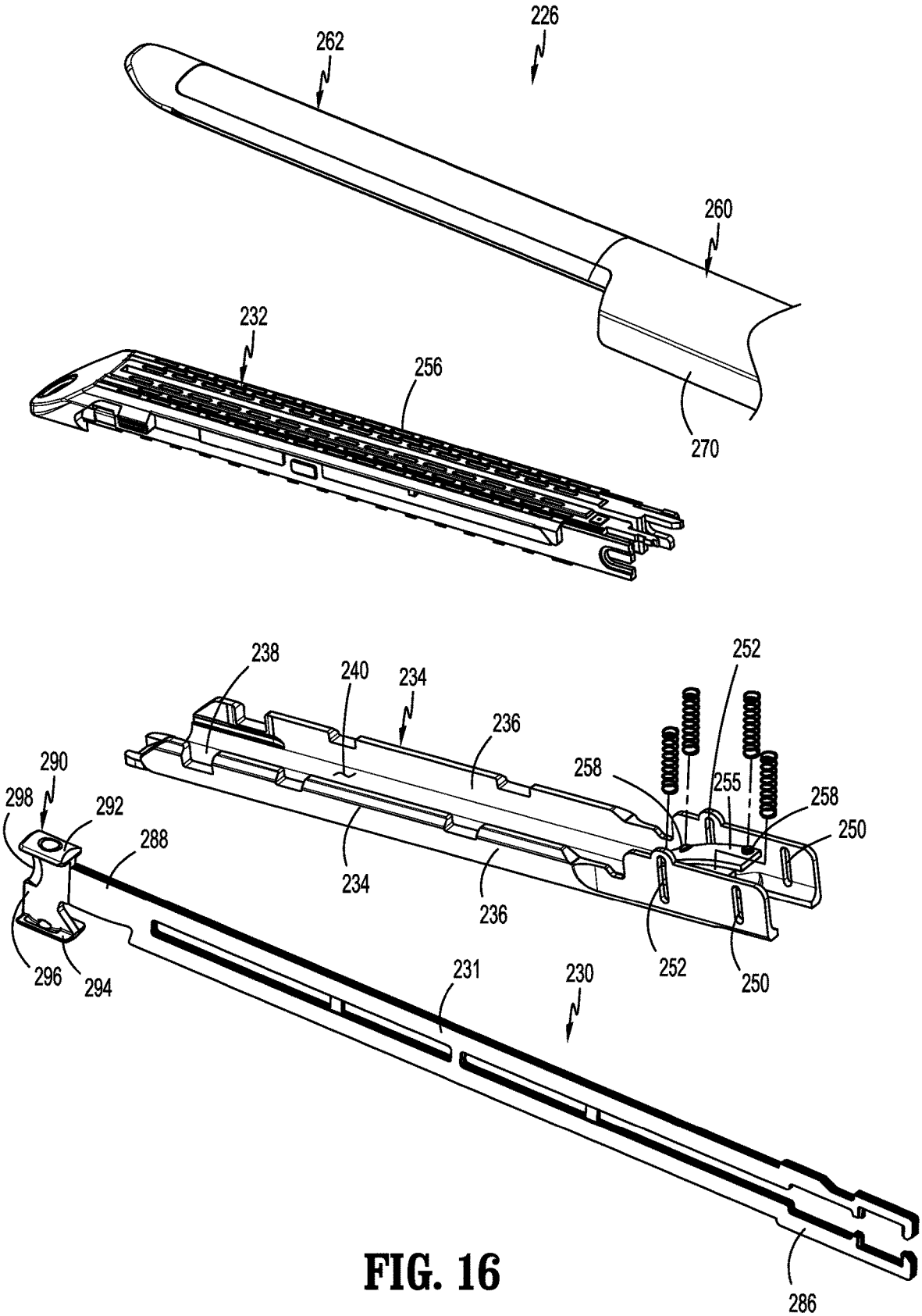


FIG. 15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231
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FIG. 16

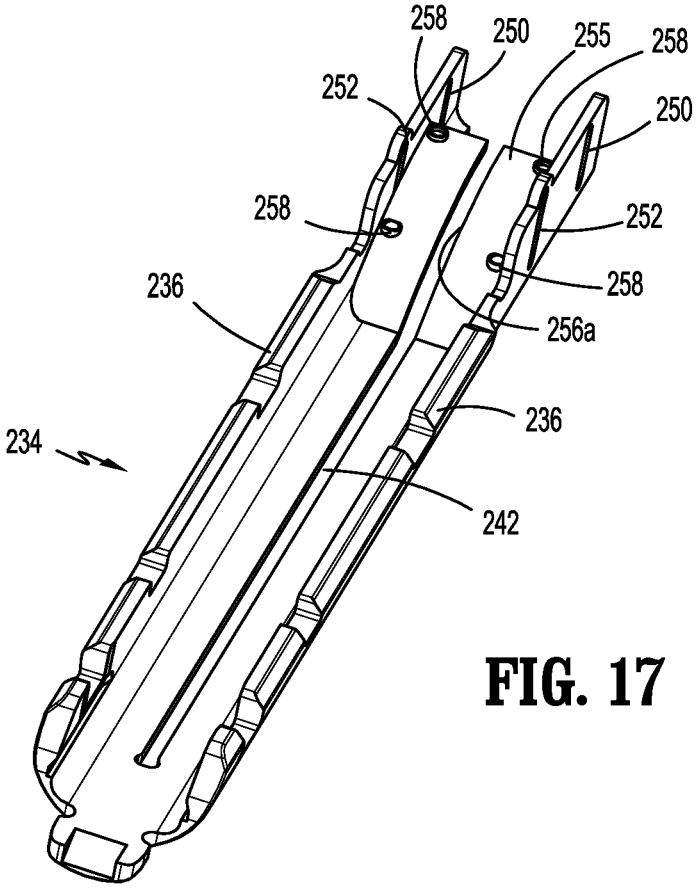
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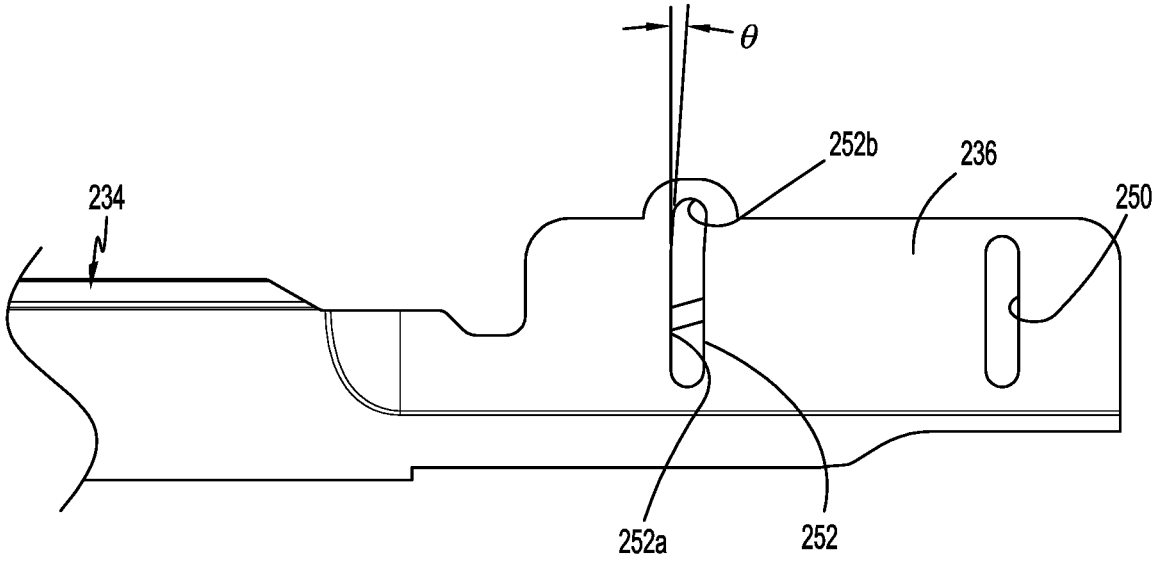
FIG. 17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252a
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FIG. 18

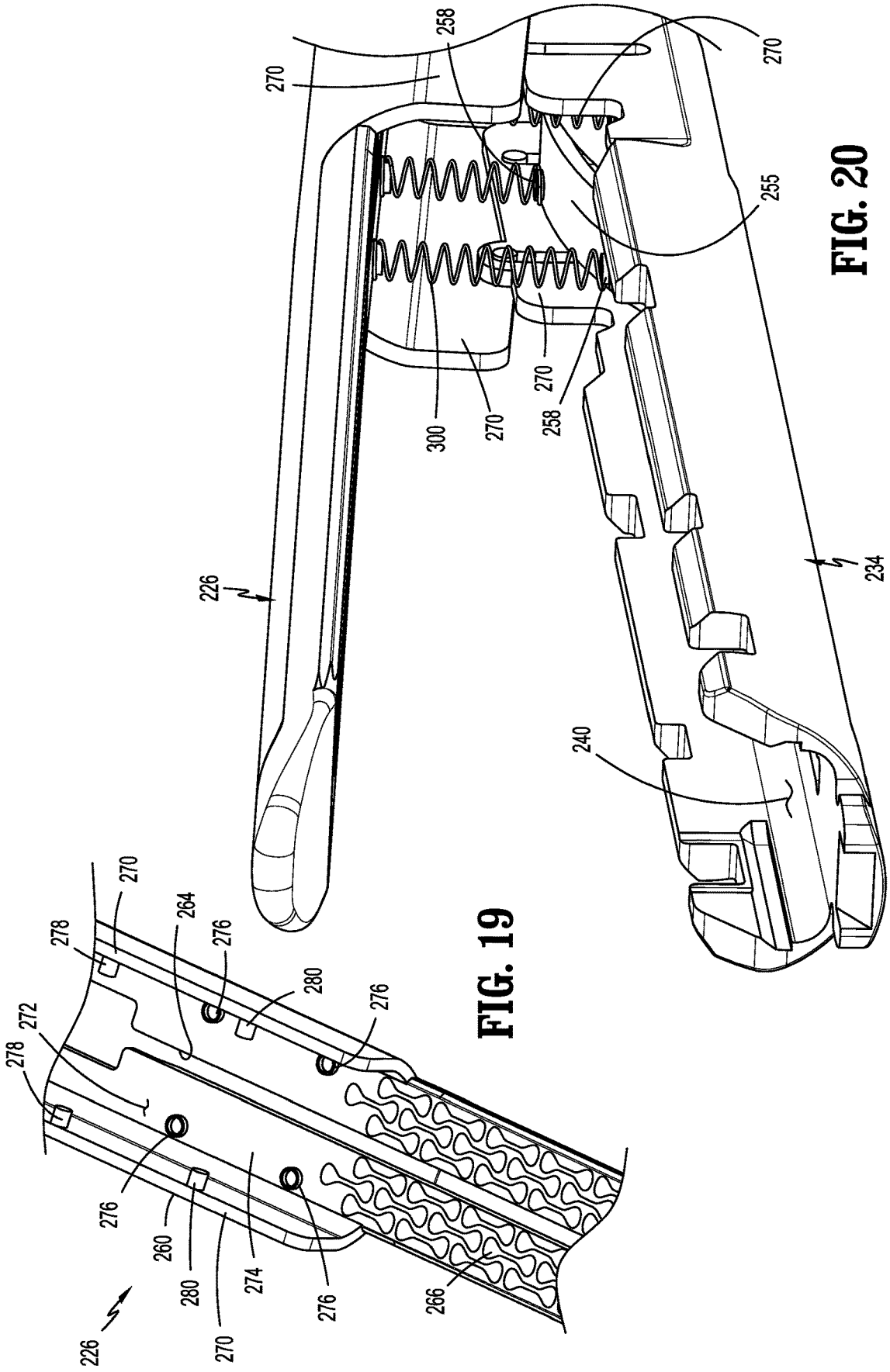
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FIG. 19

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FIG. 20

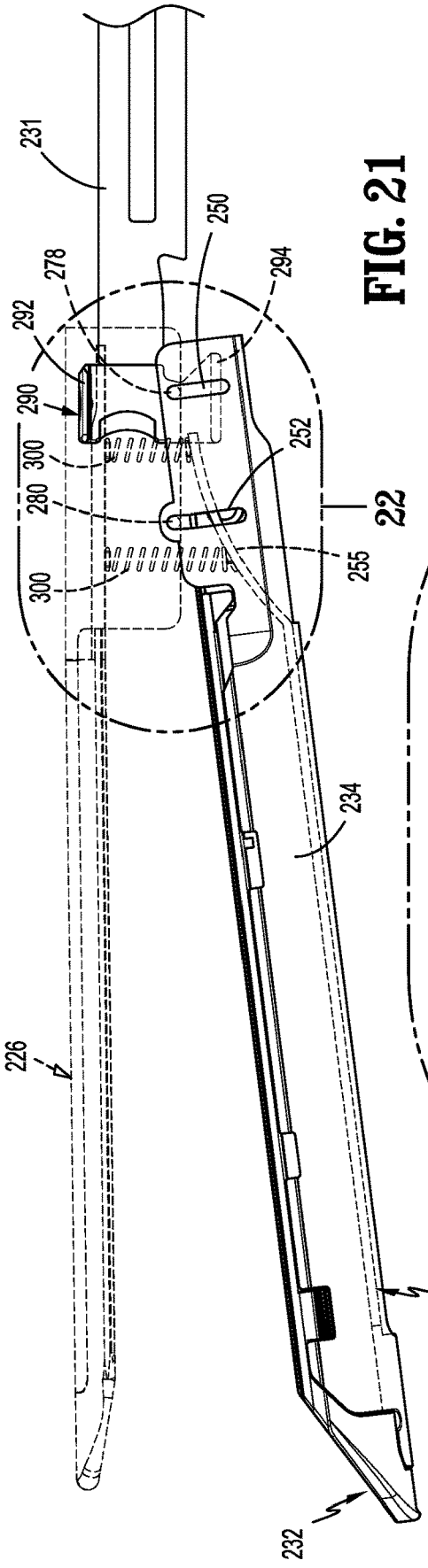


FIG. 21

22

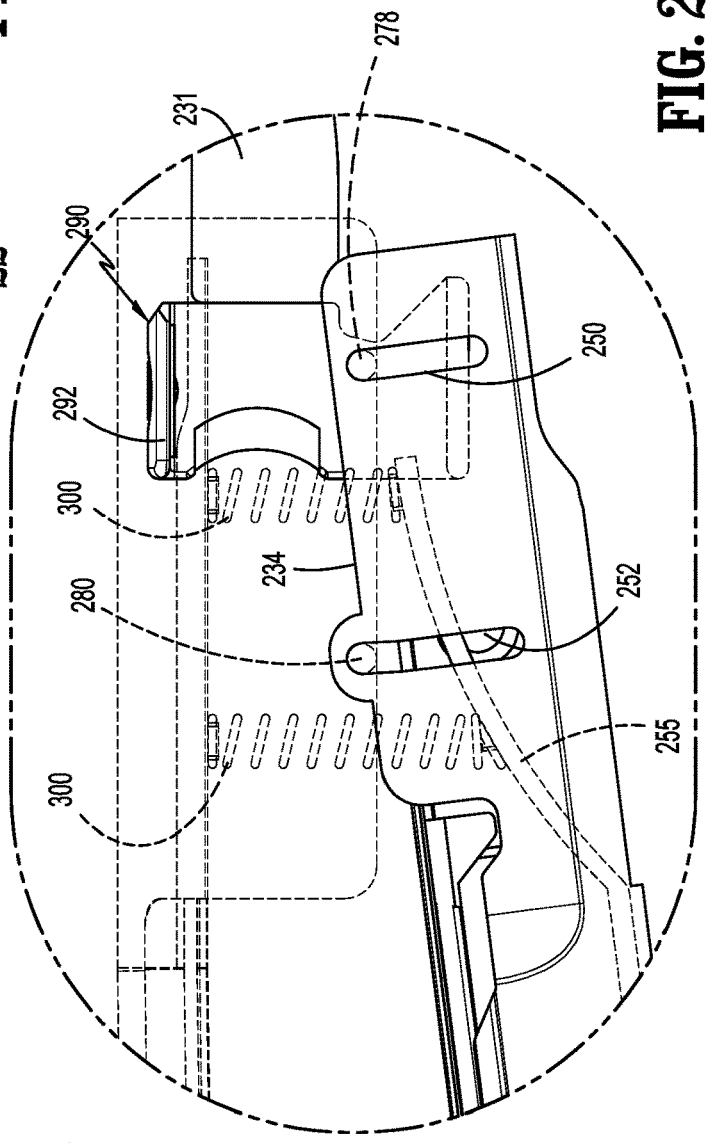
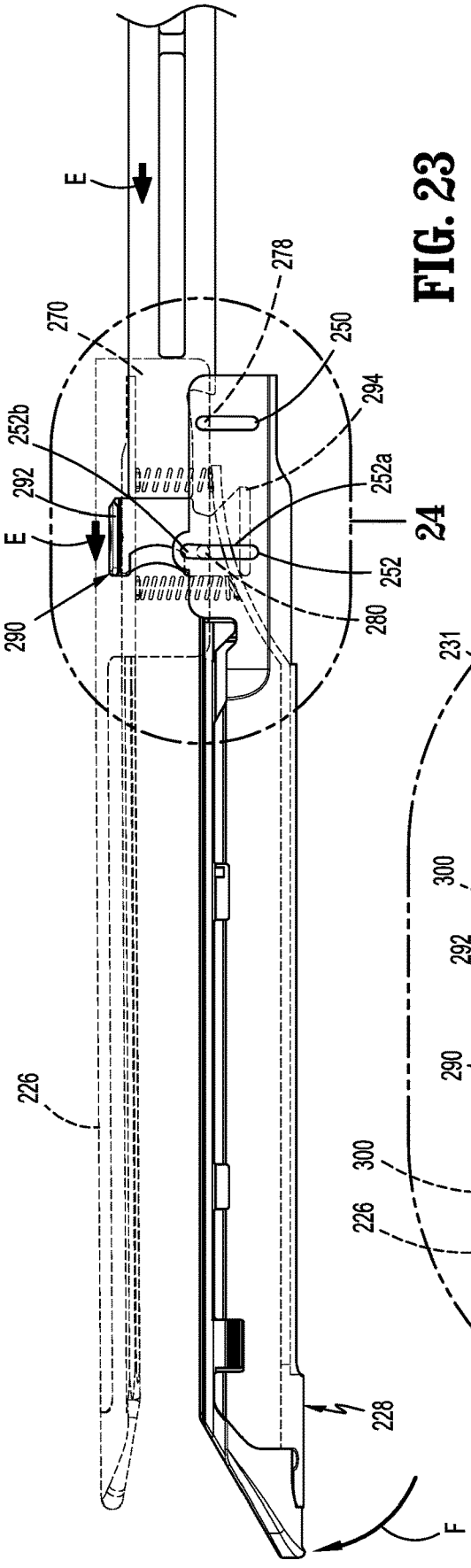


FIG. 22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F

FIG. 23

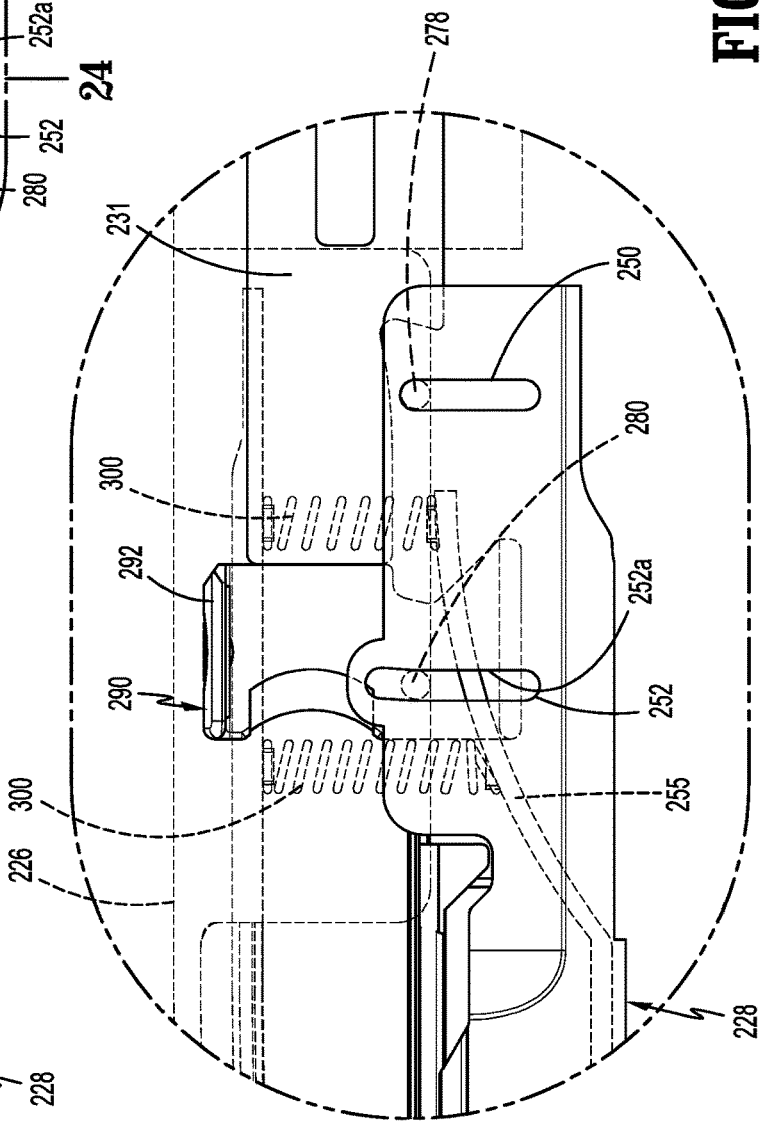
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FIG. 24

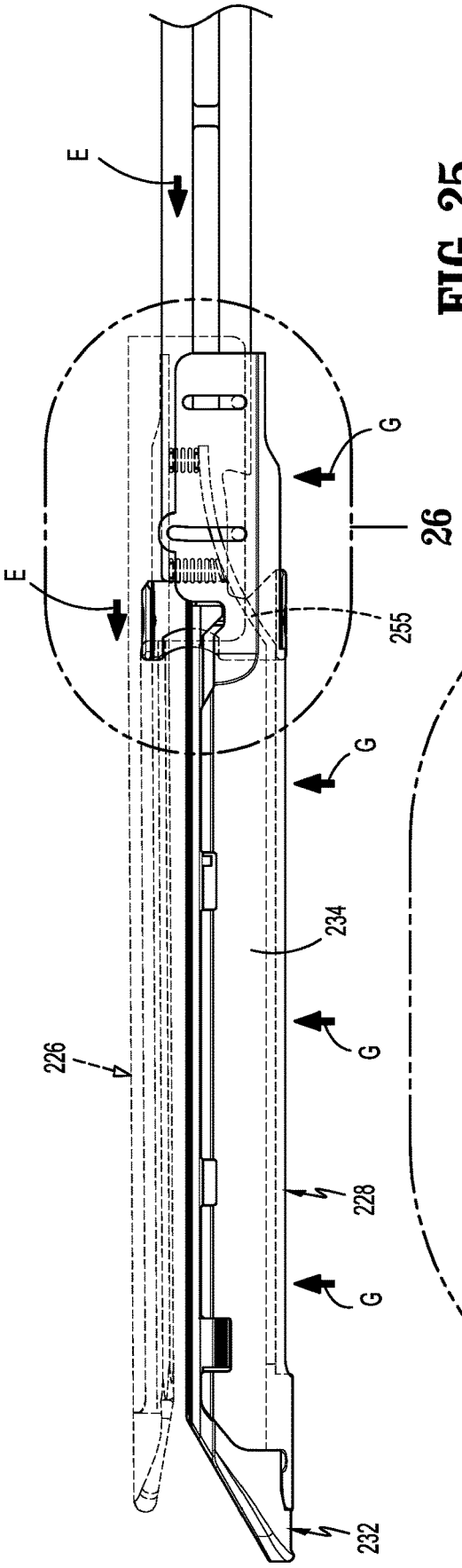

FIG. 25

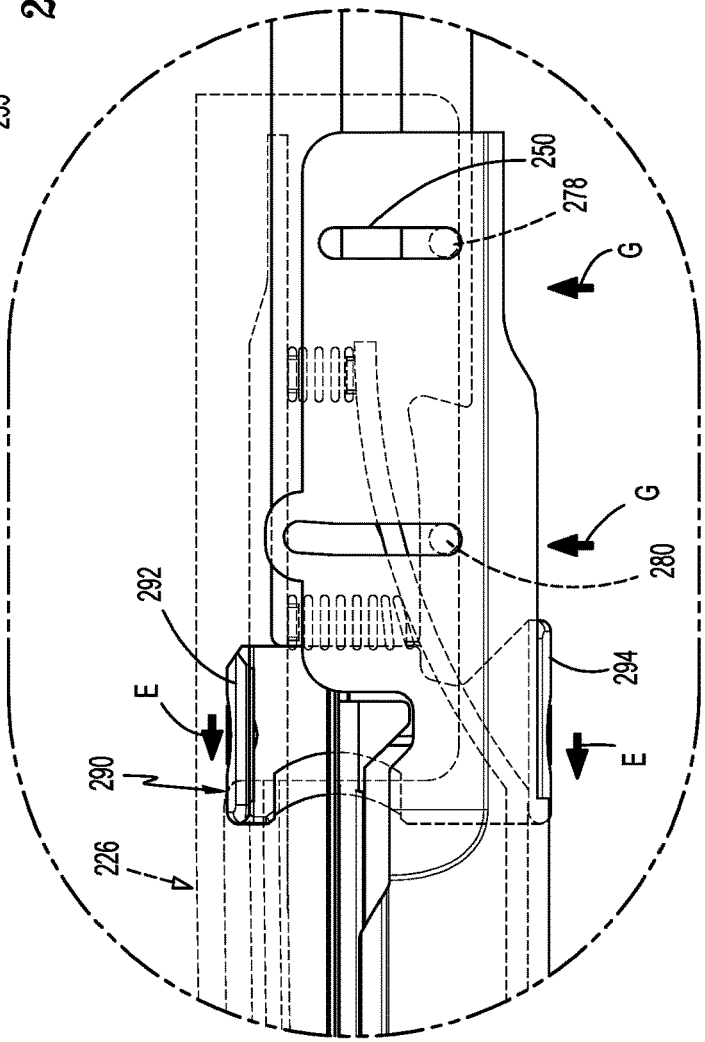

FIG. 26

SURGICAL STAPLING DEVICE WITH PARALLEL JAW CLOSURE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Divisional Application of U.S. patent application Ser. No. 16/895,164, filed on Jun. 8, 2020, the entire disclosure of which is incorporated by reference herein.

FIELD

This technology is generally related to stapling devices and, more particularly, to surgical stapling devices with parallel jaw closure.

BACKGROUND

Surgical stapling devices for simultaneously cutting and stapling tissue are known in the art and are commonly used during surgical procedures to reduce the time required to perform the surgical procedure and to facilitate endoscopic access to a surgical site. Performing a surgical procedure endoscopically reduces the amount of trauma inflicted on a patient during the surgical procedure to minimize patient discomfort and reduce patient recovery times.

Typically, endoscopic stapling devices include a tool assembly having a first jaw, and a second jaw that can pivot in relation to the first jaw between an open or spaced position and a closed or clamped position. One of the first or second jaws supports a cartridge assembly that includes a plurality of staples and the other of the first or second jaws supports an anvil assembly that includes an anvil having staple deforming pockets that receive and form legs of the staples when the staples are ejected from the cartridge assembly.

In surgical procedures that require a stapling device including a tool assembly having jaws of an extended length, e.g., bariatric procedures and procedures involving the bowel or lungs, the surgical site is confined by the anatomy of the patient. This confinement may make it difficult to move the jaws of the tool assembly to a fully open position to receive and treat tissue.

SUMMARY

In aspects, this disclosure generally relates to a surgical stapling device including an anvil, a cartridge assembly movable in relation to the anvil between open and clamped positions, a drive member, and a biasing mechanism or member. The biasing mechanism or member is configured to urge the cartridge assembly in relation to the anvil assembly to its fully open position to provide access to tissue during a surgical procedure.

One aspect of this disclosure is directed to a tool assembly including an anvil, a cartridge assembly, a biasing mechanism, and a drive member. The anvil includes a body having a proximal portion and a distal portion. The body defines a central knife slot and includes a staple forming surface. The proximal portion of the body includes spaced side walls that define an anvil cavity. At least one of the side walls supports a boss that extends into the anvil cavity. The cartridge assembly includes a channel member and a staple cartridge. The channel member includes side walls and a base wall that define a channel cavity that receives the staple cartridge. At least one of the side walls of the channel member defines a slot that extends through a portion of the respective side wall. The cartridge assembly is movable in relation to the anvil to move the tool assembly from the open position to the clamped position. The biasing mechanism includes at least one spiral spring and a roller including a toothed portion. The roller is rotatably supported between the side walls of the anvil. The at least one spiral spring includes a coil portion and a first end. The coil portion of the at least one spiral spring is supported on the boss on the at least one side wall of the anvil in a position between the anvil and the channel member. The at least one spiral spring extends through the slot in the at least one side wall of the channel member. The first end of the at least one spiral spring is connected to the roller. The drive member includes a beam portion and a working end. The drive member is movable in relation to the anvil and the cartridge assembly from a retracted position to an advanced position to actuate the tool assembly. The beam portion includes a toothed rack that is engaged with the toothed portion of the roller such that movement of the drive member from its retracted position towards its advanced position causes rotation of the roller to wind the at least one spiral spring about the roller and move the tool assembly from the open position to the clamped position.

Another aspect of the disclosure is directed to a surgical stapling device including a handle assembly, an elongate body, and a tool assembly. The handle assembly includes a stationary handle. The elongate body has a proximal portion coupled to the handle assembly and a distal portion. The tool assembly is supported on the distal portion of the elongate body and includes an anvil, a cartridge assembly, a biasing mechanism, and a drive member. The anvil includes a body having a proximal portion and a distal portion. The body defines a central knife slot and includes a staple forming surface. The proximal portion of the body includes spaced side walls that define an anvil cavity. At least one of the side walls supports a boss that extends into the anvil cavity. The cartridge assembly includes a channel member and a staple cartridge. The channel member includes side walls and a base wall that define a channel cavity that receives the staple cartridge. At least one of the side walls of the channel member defines a slot that extends through a portion of the respective side wall. The cartridge assembly is movable in relation to the anvil to move the tool assembly from the open position to the clamped position. The biasing mechanism includes at least one spiral spring and a roller including a toothed portion. The roller is rotatably supported between the side walls of the anvil. The at least one spiral spring includes a coil portion and a first end. The coil portion of the at least one spiral spring is supported on the boss on the at least one side wall of the anvil in a position between the anvil and the channel member. The at least one spiral spring extends through the slot in the at least one side wall of the channel member. The first end of the at least one spiral spring is connected to the roller. The drive member includes a beam portion and a working end. The drive member is movable in relation to the anvil and the cartridge assembly from a retracted position to an advanced position to actuate the tool assembly. The beam portion includes a toothed rack that is engaged with the toothed portion of the roller such that movement of the drive member from its retracted position towards its advanced position causes rotation of the roller to wind the at least one spiral spring about the roller and move the tool assembly from the open position to the clamped position.

In aspects of the disclosure, the at least one spiral spring includes two spiral springs.

In some aspects of the disclosure, the toothed portion of the roller is centrally located on the roller and one of the two spiral springs is positioned on each side of the toothed portion of the roller.

In certain aspects of the disclosure, each of the side walls of the channel member defines a circular concavity and the coil of each of the two spiral springs is received within a respective one of the circular concavities on the side wall of the channel member.

In aspects of the disclosure, the anvil defines a longitudinal axis and supports spaced pins, and each of the spaced pins defines a longitudinal axis that is perpendicular to the longitudinal axis of the anvil.

In some aspects of the disclosure, each of the side walls of the channel member defines a bore, and each of the spaced pins of the anvil is received within one of the bores to maintain the anvil and the cartridge assembly in parallel alignment with each other as the tool assembly is moved between the open position and the clamped position.

In certain aspects of the disclosure, the working end of the drive member includes a first beam, a second beam, and a vertical strut interconnecting the first and second beams.

In aspects of the disclosure, the first beam engages the anvil and the second beam engages the cartridge assembly to define a maximum tissue gap between the anvil and the cartridge assembly during firing of the tool assembly.

Another aspect of this disclosure is directed to a tool assembly including an anvil, a cartridge assembly, and a drive member. The anvil includes a body having a proximal portion and a distal portion. The body defines a central knife slot and includes a staple forming surface. The proximal portion of the body includes spaced side walls that define an anvil cavity. Each of the side walls supports a distal pivot member and a proximal pivot member. The distal pivot member is longitudinally spaced from the proximal pivot member. The distal and proximal pivot members extend from the respective side walls of the channel member into the anvil cavity. The cartridge assembly defines a longitudinal axis and includes a channel member and a staple cartridge. The channel member includes side walls and a base wall that define a channel cavity that receives the staple cartridge. Each of the side walls of the channel member has a proximal portion that defines first and second slots. The first and second slots define axes that are substantially perpendicular to the longitudinal axis of the cartridge assembly. The first slots are longitudinally spaced from the second slots. Each of the first slots receives a respective one of the distal pivot members and each of the second slots receives a respective one of the proximal pivot members. The cartridge assembly is movable in relation to the anvil to move the tool assembly from its open position to its clamped position. The drive member includes a beam portion and a working end. The drive member is movable in relation to the anvil and the cartridge assembly from a retracted position to an intermediate position and subsequently to a clamped position to move the cartridge assembly in relation to the anvil from the open position to the clamped position. The first and second slots are configured such that that movement of the drive member from the retracted position to the intermediate position pivots the cartridge assembly in relation to the anvil into parallel alignment with the anvil and movement of the drive member from its intermediate position to its clamped position moves the cartridge assembly in relation to the anvil to the clamped position while maintaining the cartridge assembly in parallel relation to the anvil.

In aspects of the disclosure, the first slots include an angled portion that allows the cartridge assembly to pivot in relation to the anvil as the drive member moves from its retracted position towards the intermediate position.

In some aspects of the disclosure, biasing members are supported between the proximal portion of the anvil and the proximal portion of the channel member, the biasing members urging the cartridge assembly in relation to the anvil towards its clamped position.

In certain aspects of the disclosure, the channel member supports a ramp and the working end of the drive member includes a first beam, a second beam, and a vertical strut interconnecting the first and second beams.

In aspects of the disclosure, the first beam engages the anvil and the second beam engages the ramp of the cartridge assembly as the drive member is moved from its retracted position to its clamped position to move the cartridge assembly in relation to the anvil from its open position to its clamped position.

In some aspects of the disclosure, the biasing members include coil springs that are supported between the ramp of the cartridge assembly and the anvil.

Other features of the disclosure will be appreciated from the following description.

BRIEF DESCRIPTION OF DRAWINGS

Various aspects of the disclosure are described herein below with reference to the drawings, wherein:

FIG. **1** is a perspective view of exemplary aspects of a surgical stapling device according to aspects of the disclosure;

FIG. **2** is an enlarged view of the indicated area of detail shown in FIG. **1**;

FIG. **3** is a side perspective exploded view of the tool assembly shown in FIG. **2**;

FIG. **4** is an enlarged view of the indicated area of detail shown in FIG. **3**;

FIG. **5** is a side perspective view of the anvil of the tool assembly shown in FIG. **3**;

FIG. **6** is a side perspective view of a drive assembly of the tool assembly shown in FIG. **3**;

FIG. **7** is a side perspective, cutaway view of a proximal portion of the tool assembly of the surgical stapling device shown in FIG. **1** with a channel of the tool assembly shown in phantom;

FIG. **8** is a cross-sectional view taken along section line **8-8** of FIG. **2**;

FIG. **9** is a cross-sectional view taken along section line **8-8** of FIG. **2**;

FIG. **10** is an enlarged view of the indicated area of detail shown in FIG. **9**;

FIG. **11** is a cross-sectional view taken through the tool assembly of the stapling device of FIG. **1** as the tool assembly is moved to a clamped position;

FIG. **12** is an enlarged view of the indicated area of detail shown in FIG. **11**;

FIG. **13** is a side perspective view of the tool assembly shown in FIG. **11** in an open position;

FIG. **14** is an enlarged view of the indicated area of detail shown in FIG. **13**;

FIG. **15** is an alternative version of the tool assembly of the surgical stapling device shown in FIG. **1**;

FIG. **16** is a side perspective exploded view of the tool assembly shown in FIG. **15**;

FIG. **17** is a perspective view from above of the channel of the tool assembly shown in FIG. **16**;

FIG. **18** is a side view of a proximal portion of the channel shown in FIG. **17**;

FIG. **19** is a perspective view from below of a proximal portion of the anvil of the tool assembly shown in FIG. **16**;

FIG. **20** is a perspective view from a distal end of the tool assembly shown in FIG. **15** with a staple cartridge removed from a cartridge assembly of the tool assembly and the tool assembly in the open position;

FIG. **21** is a side perspective view of the tool assembly shown in FIG. **15** in the open position with the anvil shown in phantom;

FIG. **22** is an enlarged view of the indicated area of detail shown in FIG. **21**;

FIG. **23** is a side perspective view of the tool assembly shown in FIG. **15** in the an intermediate position between the open and clamped positions with the anvil shown in phantom;

FIG. **24** is an enlarged view of the indicated area of detail shown in FIG. **23**;

FIG. **25** is a side perspective view of the tool assembly shown in FIG. **15** in the clamped position with the anvil shown in phantom; and

FIG. **26** is an enlarged view of the indicated area of detail shown in FIG. **25**.

DETAILED DESCRIPTION

The disclosed surgical stapling device will now be described in detail with reference to the drawings in which like reference numerals designate identical or corresponding elements in each of the several views. However, it is to be understood that aspects of the disclosure described herein are merely exemplary of the disclosure and may be embodied in various forms. Well-known functions or constructions are not described in detail to avoid obscuring the disclosure in unnecessary detail. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the disclosure in virtually any appropriately detailed structure. In addition, directional terms such as front, rear, upper, lower, top, bottom, distal, proximal, and similar terms are used to assist in understanding the description and are not intended to limit the disclosure.

In this description, the term "proximal" is used generally to refer to that portion of the device that is closer to a clinician, while the term "distal" is used generally to refer to that portion of the device that is farther from the clinician. In addition, the term "endoscopic" is used generally used to refer to endoscopic, laparoscopic, arthroscopic, and/or any other procedure conducted through a small diameter incision or cannula. Further, the term "clinician" is used generally to refer to medical personnel including doctors, nurses, and support personnel. As used herein, the term "substantially parallel" includes true parallel as well as 10 degrees in either direction.

FIG. **1** illustrates exemplary aspects of the disclosed surgical stapling device shown generally as stapling device **10**. Stapling device **10** includes a powered handle assembly **12**, an elongate body **14**, and a tool assembly **16**. The elongate body **14** defines a longitudinal axis "X" and includes a proximal portion **14***a* supported on the handle assembly **12** and a distal portion **14***b* that supports the tool assembly **16**. In some aspects of the disclosure, the tool assembly **16** forms part of a reload assembly **18** that includes a proximal body portion **18***a* that is releasably coupled to the distal portion **14***b* of the elongate body **14** of the stapling device **10**. The proximal body portion **18***a* includes a distal portion that supports the tool assembly **16**. Although not shown, the tool assembly **16** can be coupled to the proximal body portion **18***a* by a pivot member that facilitates articulation of the tool assembly **16** about an axis transverse to the longitudinal axis "X" of the elongate body **14**. In alternate aspects of the disclosure, the tool assembly **16** is fixedly secured to the distal portion **14***b* of the elongate body **14**. For a description of exemplary aspects of the tool assembly, see, e.g., U.S. Pat. No. 6,241,139 ("the '139 patent").

The handle assembly **12** of the stapling device **10** includes a stationary handle **20** and actuation buttons **22** that can be depressed to actuate the tool assembly **16**, e.g., approximate the tool assembly **16**, articulate the tool assembly **16**, fire staples, etc. In aspects of the disclosure, batteries (not shown) are supported in the stationary handle **20** to power the handle assembly **12**. It is envisioned that the stapling device **10** need not be powered but can also include a manually powered handle assembly such as described in the '139 patent.

FIGS. **2-4** illustrate the tool assembly **16** of the stapling device **10** in an open position. The tool assembly **16** includes an anvil **26**, a cartridge assembly **28**, and a drive member **30**. The anvil **26** is fixedly secured to a distal end of the proximal body portion **18***a* of the reload assembly **18** (or to the distal end of the elongate body **14**). The cartridge assembly **28** is supported on the anvil **26** for movement between an open position (FIG. **1**) and a clamped position (FIG. **11**) and includes a staple cartridge **32** and a channel member **34**. The channel member **34** includes side walls **36** and a base wall **38** that define a channel cavity **40** that receives the staple cartridge **32**. The base wall **38** defines a knife slot **42** that extends through the channel member **34** along most of its length and includes a closed proximal and distal end. The knife slot **42** receives a portion of the drive member **30** to facilitate movement of the drive member **30** in relation to the anvil **26** and cartridge assembly **28** between retracted and advanced positions.

The channel member **34** has a proximal portion including a base **44** that is defined by a proximal portion **36***a* (FIG. **3**) of the side walls **36** of the channel member **34**. I aspects of the disclosure, the width of the proximal portion **36***a* of the side walls **36** in the base **44** of the channel member **34** is thicker than the width of the side walls **36** in a distal portion of the channel member **34**. Each of the proximal portions **36***a* of the side walls **36** in the base **44** includes an upper surface (as viewed in FIG. **3**) that defines a bore **46** and a circular concavity **48**. The bores **46** extend along an axis that is substantially perpendicular to a longitudinal axis of the cartridge assembly **28**. The proximal portions **36***a* of the side walls **36** are spaced from each other to define a channel **50** that communicates with the channel cavity **40** and receives the drive member **30** when the drive member **30** is in its retracted position. Each of the proximal portions **36***a* of the side walls **36** of the channel member **34** also defines a circular slot **52** that extends through the side wall **36***a* from an upper surface of the side wall **36** of the channel member **34** to the proximal end of the side wall **36** of the channel member **34** (FIG. **8**).

The staple cartridge **32** is received within the channel cavity **40** and includes a cartridge body **54** that defines a central knife slot **56** and rows of staple pockets **58** on each side of the central knife slot **56**. It is envisioned that two or more rows of staple pockets can be provided on each side of the central knife slot **56**. It is also envisioned that the staple pockets **58** need not be aligned in rows but rather a variety of different arrays of staple pockets **58** can be defined on each side of the central knife slot **56**. Each of the staple pockets **58** receives a staple and a pusher (not shown). For

a more detailed description of the staple cartridge **32** including staples and pushers, see the '139 Patent.

FIGS. **3** and **5** illustrate the anvil **26** of the stapling device **10** (FIG. **1**) which includes a proximal portion **60** and a distal portion **62**. The distal portion **62** of the anvil **26** defines a central knife slot **64** and includes a staple forming surface **66**. The central knife slot **64** extends from the staple forming surface **66** and communicates with an internal channel (not shown) defined within the anvil **26**. The central knife slot **64** and the internal channel (not shown) within the anvil **26** receive a portion of the drive member **30** as the drive member **30** is moved between its retracted and advanced positions.

The proximal portion **60** of the anvil **26** includes a pair of spaced side walls **70** that defines an anvil cavity **72** that receives the base **44** of the channel member **34** when the tool assembly is in its clamped position. The anvil cavity **72** is defined in part by a base wall **74** of the anvil **26** which supports two spaced pins **76** that extend upwardly from the base wall **74** (as viewed in FIG. **5**) within the anvil cavity **72** towards the cartridge assembly **28**. The pins **76** define an axis that is substantially perpendicular to a longitudinal axis of the anvil **26** and are received within the bores **46** formed in the proximal portions **36***a* of the side walls **36** of the channel member **34**. The side walls **70** also support bosses **78** that extend from the side walls **70** into the anvil cavity **72**.

FIGS. **3** and **7** illustrate the proximal portion of the tool assembly **16** which includes a biasing mechanism **68**. The biasing mechanism **68** includes a roller **80** and a pair of biasing members **82**. The roller **80** is rotatably supported between the spaced side walls **70** of the anvil **26** and extends across the anvil cavity **72**. The roller **80** has a toothed central portion **80***a*. In aspects of the disclosure, each of the biasing members **82** includes a spiral spring **82** that has a coil portion **83** and a first end portion **84** that extends from the coil portion **83** and is secured to the roller **80**. Each of the spiral springs **82** extends through the circular slot **52** in the channel member **34**. The coil portion **83** of each of the spiral springs **82** is supported on one of the bosses **78** of the anvil **26** and sits within one of the circular concavities **48** (FIG. **3**) defined in the proximal portions **36***a* of the side walls **36** of the channel member **34**. The outer surfaces of the spiral springs **82** engage inner surfaces of the channel member **34** to urge the cartridge assembly **28** away from the anvil **26** to move the tool assembly **16** to the open position. It is envisioned that the biasing mechanism **68** can have only a single spiral spring **82**.

FIGS. **3** and **6** illustrate the drive member **30** which includes an elongate beam **31** having a proximal portion **86** and a distal portion **88**. The proximal portion **86** is configured to receive a coupling member (not shown) that couples the drive member **30** to a control rod (not shown) included in the elongate body **14** of the stapling device **10** (FIG. **1**). The control rod (not shown) is movable between a retracted position and an advanced position to move the drive member **30** between its retracted and advanced positions. The '139 Patent describes exemplary aspects of a coupling member and a control rod.

The distal portion **88** of the drive member **30** supports a working end **90** that is movable through the anvil **26** and the cartridge assembly **28** to actuate the tool assembly **16**. In aspects of the disclosure, the working end **90** of the drive member **30** includes a first beam **92**, a second beam **94**, and a vertical strut **96** that couples the first beam **92** to the second beam **94**. The vertical strut **96** supports a distally facing knife blade **98** and extends through the knife slot **64** of the anvil **26** and the knife slots **42** and **56** of the channel member **34** and the staple cartridge **32**. The first beam **92** is received within the internal channel (not shown) of the anvil **26** and the second beam **94** is engaged with the channel member **34** of the cartridge assembly **28** such that movement of the drive member **30** from its retracted position towards its advanced position defines a maximum tissue gap between the staple cartridge **32** and the staple forming surface **66** (FIG. **5**) of the anvil **26** as the tool assembly **16** is fired. It is noted that in this aspect of the disclosure, the working end **90** of the drive member **30** does not affect movement of the tool assembly **16** from its open position to its clamped position.

The elongate beam portion **31** of the drive member **30** includes a toothed rack **102**. The toothed rack **102** is engaged with the toothed central portion **80***a* of the roller **80**. When the drive member **30** is moved from its retracted position to its advanced position, engagement between the toothed central portion **80***a* of the roller **80** and the toothed rack **102** of the drive member **30** causes the roller **80** to rotate within the anvil cavity **72**. Rotation of the roller **80** winds the spiral springs **82** about the roller **80** to move the coil portions **83** of the spiral springs **82** from an expanded condition (FIG. **8**) to a contracted or condition (FIG. **12**). When the spiral springs **82** are in their expanded condition, the coil portions **83** of the spiral springs **82** are positioned between the anvil **26** and the channel member **30** of the cartridge assembly **28** and urge the cartridge assembly **28** away from the anvil **26** to move the tool assembly **16** to the open position. When the spiral springs **82** are in their contracted condition, the coil portions **83** of the spiral springs **82** are contracted about the bosses **78** of the anvil **26** and the spiral springs **82** which extend through the slots **52** in the channel member **34** pulls the cartridge assembly **28** towards the anvil **26** such that the tool assembly **16** moves from its open position to its clamped position.

FIGS. **8-10** illustrate the tool assembly **16** in the open position. In the open position of the tool assembly **16**, the drive member **30** is in a retracted position with the toothed rack **102** on the beam portion **100** of the drive member **30** engaged with the toothed central portion **80***a* of the roller **80**. When the drive member **30** is in the retracted position, the spiral springs **82** are in their expanded position such that the coil portions **83** of the spiral springs **82** urge the cartridge assembly **28** away from the anvil **26** to move the tool assembly **16** to the open position. The pins **76** of the anvil **26** are received within the bores **46** of the channel member **34** to maintain the anvil **26** in parallel alignment with the staple cartridge **32** of the cartridge assembly **28**.

FIGS. **11-14** illustrate the tool assembly **16** in the clamped position. When the drive member **30** is moved from its retracted position towards its advanced position in the direction indicated by arrows "A" in FIGS. **11** and **12**, engagement between the toothed rack **102** of the beam portion **100** of the drive member **30** and the roller **80** causes the roller **80** to rotate in the direction indicated by arrow "B" in FIG. **12** within the anvil cavity **72** of the anvil **26**. As described above, the first end **84** of the spiral spring **82** is secured to the roller **80**. Thus, as the roller **80** rotates within the anvil cavity **72**, the first end **84** of the spiral spring **82** is wound about the roller **82** to contract the coil portions **83** of the spiral springs **82** about the bosses **78**. As the spiral springs **82** are wound about the roller **80**, the spiral springs **82** which extend through the circular slots **52** of the channel member **34** pulls the cartridge assembly **28** toward the anvil **26** in the direction indicated by arrow "C" in FIG. **11** to move the tool assembly **16** to the clamped position. As described above, the pins **76** move through the bores **46** in the channel member **34** to maintain the anvil **26** and the

cartridge assembly **28** in parallel alignment as the cartridge assembly **28** moves towards the anvil **26**. In the clamped position of the tool assembly **16**, the staple forming surface **66** of the anvil **26** is in juxtaposed alignment with the staple cartridge **28**.

It is envisioned that the cartridge assembly **28** could be fixedly secured to the elongate body **14** (FIG. **1**) and the anvil **26** could be movable in relation to the elongate body **14** toward the cartridge assembly **28**.

It is noted that the beam portion **100** of the drive member **30** immediately proximal of the toothed rack **100** includes a flat surface **112** (FIG. **6**). After the tool assembly **16** is in the clamped position, the drive member **30** continues to move towards its advanced position to actuate the tool assembly **16**. The flat surface **112** allows the beam portion **100** to pass over the roller **80** without rotating the roller **80**.

FIGS. **15-26** illustrate an alternate version of the tool assembly of the stapling device **10** (FIG. **1**) shown generally as tool assembly **216**. The tool assembly **216** is like tool assembly **16** (FIG. **3**) and includes an anvil **226**, a cartridge assembly **228**, and a drive member **230** (FIG. **16**). The anvil **226** is fixedly secured to a distal end of the proximal body portion **18***a* (FIG. **1**) of the reload assembly **18** (or to the distal end of the elongate body **14**) (FIG. **1**). The cartridge assembly **228** is supported on the anvil **226** for movement between an open position (FIG. **15**) and a clamped position (FIG. **25**) and includes a staple cartridge **232** and a channel member **234**. The channel member **234** includes side walls **236** and a base wall **238** that define a channel cavity **240** (FIG. **16**) that receives the staple cartridge **232**. The base wall **238** of the channel member **234** defines a knife slot **242** (FIG. **17**) that extends through the channel member **234** along most of its length and includes a closed distal end. The knife slot **242** receives a portion of the drive member **230** to facilitate movement of the drive member **230** in relation to the anvil **226** and cartridge assembly **228** between retracted and advanced positions as described below.

FIGS. **15-18** illustrate the channel member **234** which includes a proximal portion that is defined by the side walls **236** of the channel member **234**. The proximal portion of each of the side walls **236** defines first and second slots **250** and **252** (FIG. **18**). The slots **252** are substantially linear and vertically oriented as viewed in FIG. **18**. The slots **252** are also vertically oriented and include a linear portion **252***a* and an angled portion **252***b*. The angled portion **252***b* of each of the slots **252** defines an angle θ with the axis of the linear portion. The angle θ is selected to allow the channel member **234** to pivot in relation to the anvil **226** from a pivoted position (FIG. **21**) to a position in parallel alignment with the anvil **26** (FIG. **23**) and can be from about 1 degree to about 5 degrees. In some aspects of the disclosure, angle θ is about 3 degrees.

The channel member **234** includes a ramp **255** that is supported between the proximal portion of the side walls **236**. The ramp **255** defines a knife slot **255***a* that is aligned with the knife slot **242** (FIG. **17**) of the channel member **234** and supports a pair of spring mounts **258** which are positioned on each side of the knife slot **256***a*.

The staple cartridge **232** is received within the channel cavity **240** of the channel member **234** and includes a cartridge body **254** that defines a central knife slot **256** and rows of staple pockets **257** on each side of the central knife slot **256**. It is envisioned that two or more rows of staple pockets **257** can be provided on each side of the central knife slot **256**. It is also envisioned that the staple pockets **257** need not be aligned in rows but rather a variety of different arrays of staple pockets **257** can be defined on each side of the central knife slot **256**. Each of the staple pockets **257** receives a staple and a pusher (not shown). For a more detailed description of an exemplary staple cartridge **232** including staples and pushers, see the '139 Patent.

FIGS. **16** and **19** illustrate the anvil **226** which includes a proximal portion **260** and a distal portion **262**. The distal portion **262** of the anvil **226** defines a central knife slot **264** and includes a staple forming surface **266**. The central knife slot **264** extends through the staple forming surface **266** and communicates with an internal channel (not shown) defined within the anvil **226**. The central knife slot **264** and the internal channel (not shown) within the anvil **226** receive a portion of the drive member **230** as the drive member **30** is moved between its retracted and advanced positions as described in further detail below.

The proximal portion **260** of the anvil **226** includes a pair of spaced side walls **270** that defines an anvil cavity **272** that receives the proximal portion of the channel member **234**. The anvil cavity **272** is defined in part by a base wall **274** of the anvil **226**. The base wall **274** defines a continuation of the central knife slot **264** such that the central knife slot **264** extends through a proximal end of the base wall **274**. The base wall **274** includes spring mounts **276** (FIG. **19**). The side walls **270** support pivot members **278** and **280** that extend from the side walls **270** inwardly into the anvil cavity **272**. The pivot members **280** are positioned distally of the pivot members **278** and are received within the first slots **250** of the channel member **234**. The pivot members **280** are received within the second slots **252** of the channel member.

FIG. **16** illustrates the drive member **230** which includes an elongate beam portion **231** including a proximal portion **286** and a distal portion **288**. The proximal portion **286** is configured to receive a coupling member (not shown) that couples the drive member **230** to a control rod (not shown) included in the elongate body **14** of the stapling device **10** (FIG. **1**). The control rod (not shown) is movable between a retracted position and an advanced position to move the drive member **230** between its retracted and advanced positions. The '139 Patent describes exemplary aspects of a coupling member and a control rod. The distal portion **288** of the elongate beam **231** supports a working end **290** that is movable through the anvil **226** and the cartridge assembly **228** to actuate the tool assembly **216**. In aspects of the disclosure, the working end **290** of the drive member **230** includes a first beam **292**, a second beam **294**, and a vertical strut **296** that couples the first beam **292** to the second beam **294**. The vertical strut **296** supports a distally facing knife blade **298** and extends through the knife slot **264** (FIG. **19**) of the anvil **226** and the knife slots **242** (FIG. **17**) and **256** of the channel member **234** and the staple cartridge **232**, respectively. The first beam **292** is received within the internal channel (not shown) of the anvil **226** and the second beam **294** is engaged with the channel member **234** of the cartridge assembly **228** such that movement of the drive member **230** from its retracted position towards its advanced position moves the cartridge assembly **228** towards the anvil **226** to move the tool assembly **216** to the clamped position (FIG. **25**) and define a maximum tissue gap between the staple cartridge **232** and the staple forming surface **266** (FIG. **5**) of the anvil **226** as the tool assembly **216** is fired.

FIGS. **16** and **20** illustrate the biasing members **300** of the tool assembly **16**. In aspects of the disclosure, the biasing members **300** include coil springs, e.g., **4**, that are positioned between the proximal portions of the anvil **226** and the channel member **228**. The coil springs **300** have a first end secured to the spring mounts **258** on the channel member **234** and a second end secured to the spring mounts **276** on

the base wall **274** of the anvil **226**. The coil springs **300** urge the proximal portions of the anvil **226** and channel member **234** of the cartridge assembly **228** apart to move the tool assembly **216** to its open position.

FIGS. **21** and **22** illustrate the tool assembly **216** in the open position. In the open position, the drive member **230** is in its retracted position with the working end **290** of the drive member **230** positioned proximally of the ramp **255**, and the pivot members **278** and **280** are positioned within upper ends of the slots **250** and **252** of the channel member **234**. The coil springs **300** which are engaged with the proximal portions of the anvil **226** and cartridge assembly **228** urge the proximal portions of the anvil **226** and the cartridge assembly **228** apart to move the tool assembly **216** to the open position.

FIGS. **23** and **24** illustrate the tool assembly **216** as the tool assembly **216** is moved from the open position towards the clamped position. When the drive member **230** is moved from its retracted position towards its advanced position in the direction indicated by arrows "E" in FIG. **23**, the second beam **294** of the working end **290** of the drive member **230** engages and moves along an underside of the ramp **255** and pivots the cartridge assembly **228** about the pivot member **278** in the direction of arrow "F" in FIG. **23** towards the anvil **226** to an intermediate position in which the cartridge assembly **228** is in parallel alignment with the anvil **226**. As the cartridge assembly **228** pivots to the intermediate position, the pivot members **280** move within the angled portions **252***b* of the second slots **252** towards the linear portions **252***a* of the slots **252**.

FIGS. **25** and **26** illustrate the tool assembly **216** as the tool assembly **216** is moved from the intermediate position towards the clamped position. When the drive member **230** is moved from the position shown in FIG. **23** towards its advanced position in the direction indicated by arrows "E" in FIG. **25**, the second beam **294** of the working end **290** of the drive member **230** continues to engage and move along the underside of the ramp **255** to urge the cartridge assembly **228** in the direction of arrows "G" in FIG. **25** towards the anvil **226** and towards the clamped position in which the cartridge assembly **228** is in juxtaposed parallel alignment with the anvil **226**. As the cartridge assembly **228** moves to the clamped position, the pivot members **280** move within the linear portions **252***a* of the slots **252** and the pivot members **278** move within the linear slots **250** to maintain the anvil **226** and the cartridge assembly **228** in substantially parallel alignment.

Although not shown, continued movement of the drive member **230** in relation to the anvil **226** and the cartridge assembly **228** towards its advanced position fires staples from the staple cartridge **232** of the cartridge assembly **228** into the gap defined between the staple forming surface **266** of the anvil **226** and the staple cartridge **232** of the cartridge assembly **228** and into the staple forming surface **266** of the anvil assembly **226**. For a more detailed description of the operation and firing of an exemplary tool assembly, see the '139 Patent.

Persons skilled in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary aspects of the disclosure. It is envisioned that the elements and features illustrated or described in connection with one exemplary embodiment may be combined with the elements and features of another without departing from the scope of the present disclosure. As well, one skilled in the art will appreciate further features and advantages of the disclosure based on the above-described aspects of the disclosure. Accordingly, the disclosure is not to be limited by what has been particularly shown and described, except as indicated by the appended claims.

What is claimed is:

1. A tool assembly comprising:

an anvil including a body having a proximal portion and a distal portion, the body defining a central knife slot and including a staple forming surface, the proximal portion of the body including spaced side walls defining an anvil cavity, each of the side walls supporting a distal pivot member and a proximal pivot member, the distal pivot member longitudinally spaced from the proximal pivot member, the distal and proximal pivot members extending from the respective side walls of the channel member into the anvil cavity;

a cartridge assembly defining a longitudinal axis and including a channel member and a staple cartridge, the channel member including side walls and a base wall that define a channel cavity that receives the staple cartridge, each of the side walls of the channel member having a proximal portion that defines first and second slots, the first and second slots defining axes that are substantially perpendicular to the longitudinal axis of the cartridge assembly, the first slots being longitudinally spaced from the second slots, each of the first slots receiving a respective one of the distal pivot members, and each of the second slots receiving a respective one of the proximal pivot members, the cartridge assembly movable in relation to the anvil to move the tool assembly from an open position to a clamped position; and

a drive member including a beam portion and a working end, the drive member movable in relation to the anvil and the cartridge assembly from a retracted position to an intermediate position and subsequently to a clamped position to move the cartridge assembly in relation to the anvil from the open position to the clamped position, wherein the first and second slots are configured such that movement of the drive member from the retracted position to the intermediate position pivots the cartridge assembly in relation to the anvil into parallel alignment with the anvil and movement of the drive member from its intermediate position to its clamped position moves the cartridge assembly in relation to the anvil to the clamped position while maintaining the cartridge assembly in parallel relation to the anvil.

2. The tool assembly of claim **1**, wherein the first slots include an angled portion that allows the cartridge assembly to pivot in relation to the anvil as the drive member moves from its retracted position towards the intermediate position.

3. The tool assembly of claim **2**, further including biasing members supported between the proximal portion of the anvil and the proximal portion of the channel member, the biasing members urging the cartridge assembly in relation to the anvil towards its open position.

4. The tool assembly of claim **3**, wherein the channel member supports a ramp, and the working end of the drive member includes a first beam, a second beam, and a vertical strut interconnecting the first and second beams, the first beam engaging the anvil and the second beam engaging the ramp of the cartridge assembly as the drive member is moved from its retracted position to its clamped position to move the cartridge assembly in relation to the anvil from its open position to its clamped position.

5. The tool assembly of claim **4**, wherein the biasing members include coil springs that are supported between the ramp of the cartridge assembly and the anvil.

6. The tool assembly of claim 5, wherein the ramp supports spring mounts that secure the coil springs to the ramp.

7. The tool assembly of claim 6, wherein the channel member defines a central knife slot, and the ramp supports two spring mounts on each side of the central knife slot of the channel member.

8. The tool assembly of claim 7, wherein the two spring mounts on each side of the central knife slot of the channel member are longitudinally spaced from each other.

9. The tool assembly of claim 8, wherein the biasing members include four biasing members, one of the biasing members secured to each of the spring mounts on the ramp.

10. A surgical stapling device comprising:

a handle assembly including a stationary handle;

an elongate body having a proximal portion and a distal portion, the proximal portion coupled to the handle assembly; and

a tool assembly supported on the distal portion of the elongate body, the tool assembly including:

an anvil including a body having a proximal portion and a distal portion, the body defining a central knife slot and including a staple forming surface, the proximal portion of the body including spaced side walls defining an anvil cavity, each of the side walls supporting a distal pivot member and a proximal pivot member, the distal pivot member longitudinally spaced from the proximal pivot member, the distal and proximal pivot members extending from the respective side walls of the channel member into the anvil cavity;

a cartridge assembly defining a longitudinal axis and including a channel member and a staple cartridge, the channel member including side walls and a base wall that define a channel cavity that receives the staple cartridge, each of the side walls of the channel member having a proximal portion that defines first and second slots, the first and second slots defining axes that are substantially perpendicular to the longitudinal axis of the cartridge assembly, the first slots being longitudinally spaced from the second slots, each of the first slots receiving a respective one of the distal pivot members, and each of the second slots receiving a respective one of the proximal pivot members, the cartridge assembly movable in relation to the anvil to move the tool assembly from the open position to the clamped position; and

a drive member including a beam portion and a working end, the drive member movable in relation to the anvil and the cartridge assembly from a retracted position to an intermediate position and subsequently to a clamped position to move the cartridge assembly in relation to the anvil from the open position to the clamped position, wherein the first and second slots are configured such that movement of the drive member from the retracted position to the intermediate position pivots the cartridge assembly in relation to the anvil into parallel alignment with the anvil and movement of the drive member from its intermediate position to its clamped position moves the cartridge assembly in relation to the anvil to the clamped position while maintaining the cartridge assembly in parallel relation to the anvil.

11. The surgical stapling device of claim 10, wherein the first slots include an angled portion that allows the cartridge assembly to pivot in relation to the anvil as the drive member moves from its retracted position towards the intermediate position.

12. The surgical stapling device of claim 11, further including biasing members supported between the proximal portion of the anvil and the proximal portion of the channel member, the biasing members urging the cartridge assembly in relation to the anvil towards its open position.

13. The surgical stapling device of claim 12, wherein the channel member supports a ramp, and the working end of the drive member includes a first beam, a second beam, and a vertical strut interconnecting the first and second beams, the first beam engaging the anvil and the second beam engaging the ramp of the cartridge assembly as the drive member is moved from its retracted position to its clamped position to move the cartridge assembly in relation to the anvil from its open position to its clamped position.

14. The surgical stapling device of claim 13, wherein the biasing members include coil springs that are supported between the ramp of the cartridge assembly and the anvil.

15. The surgical stapling device of claim 14, wherein the ramp supports spring mounts that secure the coil springs to the ramp.

16. The surgical stapling device of claim 15, wherein the channel member defines a central knife slot, and two of the spring mounts are supported on the ramp on each side of the central knife slot of the channel member.

17. The surgical stapling device of claim 16, wherein the two spring mounts on each side of the central knife slot of the channel member are longitudinally spaced from each other.

18. The surgical stapling device of claim 17, wherein the biasing members include four biasing members, one of the biasing members secured to each of the spring mounts on the ramp.

19. A tool assembly comprising:

an anvil including a body having a proximal portion and a distal portion, the body defining a central knife slot and including a staple forming surface, the proximal portion of the body including spaced side walls defining an anvil cavity, each of the side walls supporting a distal pivot member and a proximal pivot member, the distal pivot member longitudinally spaced from the proximal pivot member, the distal and proximal pivot members extending from the respective side walls of the body of the anvil into the anvil cavity;

a cartridge assembly defining a longitudinal axis and including a channel member and a staple cartridge, the channel member including side walls and a base wall that define a channel cavity that receives the staple cartridge, each of the side walls of the channel member having a proximal portion that defines first and second slots, the first and second slots defining axes that are substantially perpendicular to the longitudinal axis of the cartridge assembly, the first slots being longitudinally spaced from the second slots, each of the first slots receiving a respective one of the distal pivot members, and each of the second slots receiving a respective one of the proximal pivot members, the cartridge assembly movable in relation to the anvil to move the tool assembly from an open position to a clamped position; and

biasing members supported between the proximal portion of the anvil and the proximal portion of the channel member, the biasing members urging the cartridge assembly in relation to the anvil towards the open position.

20. The tool assembly of claim **19**, wherein the channel member includes a ramp that is positioned between the side walls of the channel member in the proximal portion of the channel member, the biasing members including coil springs that are supported between the ramp of the cartridge assembly and the anvil.

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